DOCUMENT RESUME

ED 084 855 EM 011 677

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TITLE	Computer Impact On Society; Perspective On a New NSF Initiative.
INSTITUTION	National Science Foundation, Washington, D.C.
PUB DATE	73
NOTE	7p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Computers; Computer Science; *Culture; *Federal Aid; Information Science; Research Needs; *Social Systems
IDENTIFIERS	National Science Foundation; Office of Computing Activities

ABSTRACT

A longstanding interest of the National Science Foundation's Office of Computing Activities in the impact of computers on society has evolved over the last two years into a new administrative unit--the Computer Impact on Society Section. Presently funded research and future directions for research on computers and society are discussed. (Author/RH)

ED 084855

Computer Impact On Society
Perspective On A New NSF Initiative

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ABSTRACT

A longstanding interest in the Office of Computing Activities, National Science Foundation, in the impact of computers on society has, over the past two years, evolved rapidly into a new administrative unit, the Computer Impact on Society Section in OCA.

This nebulous area has already been given form through a set of funded grant proposals.

Some expected future directions of growth for the program are discussed.

KEY WORDS AND PHRASES: societal impact, NSF, organizations, individual, management support, human/machine interface, citizen access, data banks, public attitudes.

PHILOSOPHICAL BACKGROUND

Computer based technology is one of man's most powerful tools, and like all powerful tools, holds simultaneously great potential for benefiting mankind and great potential for harm. While society is said by some to be growing increasingly "anti-science" in its orientation because of its growing awareness of this duality, there is little evidence of this at the operating Federal level. On all sides of the political spectrum one detects a continuing faith in the ability of science and technology to help solve our problems. Yet this faith should no longer be the blind and unquestioning faith of past decades, as there is a growing awareness, on one hand, that the negative aspects of our technology must be understood and controlled, and a dim but growing realization on the other, that at least some of our problems can never be solved with technology alone. Given the large effort aimed at implementing computer technology, there is a clear need to support a concomitant research effort to better understand the potential impact of the computer and improve our ability to use it effectively in solving social problems.

From a global view there are patterns to many problems of society which appear to be common and to call for at least partial computer solutions. The patterns can be categorized in many ways. We suggest the four below.

- Information Overload - Decision makers find themselves faced with more data than they can handle, much of which they don't need, much of which is in a form they can't use. We need techniques for digesting this flood and putting out the information appropriate to the planner's needs.

- System Complexity - Many problems we are now struggling with are systemic in nature, arising from complex interactions of many sub-systems. The economy is one example of such a system, the human body, another. When the economist or doctor cannot pin a problem down to a specific and single malfunction, treatment becomes an art rather than science. Computers offer a means of studying these complex systems and tools for dealing with them.

- Response Speed - This category refers to the need to process information quickly; to clear a check the next day, identify a stolen car, reroute traffic flow dynamically, put a citizen with a problem in touch quickly with the appropriate government or private agency or notify a doctor about changes in vital signs of his critically ill patient.

- Service Productivity - As our economy becomes increasingly service oriented there is growing pressure to distribute the services more widely throughout society and provide a greater diversity in the service available. Whether the service lies in the educational, medical, legal or some other field, distributing it more widely implies an increase in the productivity of service delivered systems. Again, computers offer the potential to do this job.

The computer is already playing an important role in society, and the issues outlined above indicate that it will grow even more in social importance. Yet, computers present, to many people at least, a potential threat. It is more risky to

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try to categorize threats, real and perceived, than to point out advantages, for fears tend to be more vague and often poorly articulated. We suggest the following, however, as some of the more common ones.

- Threat to Self-Image - Philosophers and writers have dealt with the potential threat of modern technology, most notably computers, to our self concept. One hears continually about the "dehumanization" created by machines. On the more scientific level, social scientists and social psychologists have noted some evidence of alienation and stress associated with working in a heavily automated environment.

- Sharpening of Value Conflicts - Since most computer applications are motivated by some need, they usually do not represent purely a threat to a specific social value, but rather sharpen the conflict between two or more values or perceived social needs. For example, the right to privacy conflicts with the right of society to protect itself through police data files and other surveillence techniques. The desire to personalize education may conflict with the need to distribute its benefits more widely and uniformly.

- A Tool for Malevolence - Noting that most tools are morally neutral, some people fear the introduction of any new, more powerful tool on general principle since it can be used for evil as well as good, both by governments and individuals or groups.

Implicit in most of these concerns is, we feel, the fear of loss of control, whether it be the individual dealing with his government or credit card agency or smaller governments dealing with the Federal agencies. There is a strain of concern that our information and control systems will become so complex that we no longer will understand how or why decisions are made, nor will we know how to influence them. There is the complementary concern that concentration of power will gravitate to those individuals or sectors which constitute an elite based on sophistication in data banks and data handling.

NEEDS AND OPPORTUNITIES

It is against this philosophical background that the Computer Impact on Society Section (1) was formed in the National Science Foundation last November, see Table 1. Clearly, a research program within the National Science Foundation, and more specifically the Office of Computing Activities, cannot deal equally effectively with all of the concerns expressed in the previous section. There is a need to focus on specific problems which may be amenable to solution through supported research. A brief summary of the research already supported by OCA in the Computer Impact on Society area is provided in Table 2 and constitutes a set of concrete examples which begins to give sharper definition to this broad, important, but nebulous subject area outlined in Table 1.

In this section of the paper we will discuss a few examples of what we view as major issues which we would like to see addressed. These few examples certainly do not delimit the scope of the program interests, but they will give a flavor of what we are all about and give further amplification to how our filter mechanism translates the larger philosophical issues.

We should remark here that the program is currently in a problem definition stage and is being funded at a modest level.

Problems and Opportunities in Access and Control

One important class of problems is well characterized by the term access. In its simplest form these problems involve matters such as citizen access to information which is legally in the public domain, but which is stored in some type of automated data base, and hence very often not readily available to non-technical users. What is required is research in the development of economically feasible transparent data bases. The solution may often not be entirely technical. While it is of course possible to build very transparent software, in the short run better public service per unit cost may often be provided by combining moderately transparent software with trained access specialists. The airline reservation industry offers perhaps the best current example of such a solution.

Transparency is of course not the only concern in developing systems which enhance access to and use of automated data bases. Important questions involving data accuracy and currency, individual privacy, and various types of security must also be addressed from a technical as well as a social and legal perspective.

While it is an important and pressing problem, access to information alone represents only a portion of the problem in the area of access. To borrow from Tony Oettinger's (2) absurd vocabulary "pure cow" without "bull" is frequently useless... which translates to the observation that data alone without the ability to manipulate it and apply it in the context of conceptual models is generally of little value. Automated simulation and modeling tools are rapidly becoming an integral part of most modern administrative and decision-making processes. Concentrated in the hands of a few technocrats such tools represent a serious potential threat to open democratic decision-making processes. Even apparently simple and innocuous computer based tools designed to optimize the location of fire stations, redesign the financing of service agencies, or reschedule legislative committee meeting times, can, and probably have been used by their designers to effect changes of which the general public is unaware.

Research is needed to develop mechanisms which facilitate public access to the design, control, and use of automated decision-making tools so that they can become public instruments to the greatest possible extent. Such research will necessarily be interdisciplinary but the fields of computer science and system design will play a very central role.

What do we mean by public access to automated decision-making tools? Not remote terminals in the local supermarket so that shoppers can sit down and write their own regional land use planning models! But, for example, in the case of regional

TABLE 1: Summary of the NSF Computer Impact on Society Programs in the Office of Computing Activities

The programs of the newly created Computer Impact on Society Section of the NSF-Office of Computing Activities reflect a concern about the growing need to understand the wide and deep impact which computers and associated information technology are having on our social organizations and way of life. Initially the CIS Section will be concerned with two programmatic thrusts:

1. Computer Impact on Organizations - This program supports projects in the areas of scientific activities concerned with creative use of computer and information technology supportive to management and decision making at all levels; computer impact problems in such areas as law and economics; and real-time computer use in process automation, robotics, traffic flow, and other new fields.

2. Computer Impact on the Individual - This program is concerned with scientific activities regarding use by citizens of machine-based information resources with emphasis on ease of access, accuracy, intelligibility, confidentiality, and related problems; human and technical approaches to improving communication through the human-machine interface especially for non-technical users; the development of computer and information technology which will service individual human needs; and the study of computer impact on individual life styles.

These NSF programs were established formally on November 9, 1972.

TABLE 2: Summary of Recent Grants Made by the NSF Office of Computing Activities in the Area of Computer Impact on Society

Research Related to Public Attitudes Perception and Literacy:

- An inventory of research measuring public perception of computer based technology
- Support for the "Society and the Computer" exposition at ACM 73.
- An exploratory workshop on research problem definition on public attitudes, perception and literacy.

Research Related to Information Systems for Management and Decision Making:

- An exploratory workshop on research problem definition in MIS and simulation.
- Development of a user oriented interface for a water quality planning system.
- Graphics oriented research on city planning in the New York City environment(*).
- Development of a graduate curriculum and competency check-list for specialists in management science.
- Design of a software clearinghouse for local and regional governments.
- An exploratory workshop on research problem definition on simulation and modeling(*).
- Design of a mini-computer based environment for data base management and simulation.

Research Related to Security and Privacy:

- Studies of the effect of application oriented languages on cost of computer privacy and security.
- Two exploratory workshops defining the current status of work in privacy and controlled accessability.

Research Related to Citizen Access and the Human-Machine Interface:

- Design of a citizen evaluation component in a regional planning system for the extended San Diego area.
- An exploratory workshop on research problem definition on simulation and modeling(*).
- Support for the testing of an in-house computer based interactive urban cable TV system.
- Graphics oriented research on city planning in the New York City environment(*).

Research Related to the Legal and Economic impacts of Computers:

- Workshop on computers and law oriented toward training programs in law schools.
- Two exploratory workshops on research problem definition in fields related to economics, government and law.

Research in Other Areas of Computer Impact on Society:

- A delphi study of expected social impacts in artificial intelligence.
- A computer based laboratory for research in management and behavioral science.
- Research in the Development of Computer based conferencing.
- Support for the IEEE International Conference on Computers and Communication (Technology, Law, Economics).
- Exploratory workshops on manpower problems and system performance problems.

*Two items have been double listed.

planning models, it is important that the local planning agency promote as much citizen interaction with the modeling system as possible. Most models of this type contain an assumed value orientation. These value orientations must be brought out and made into explicit inputs with which individuals and public interest groups can work so that output stability with respect to alternative value assumptions can be explored. Research on problems of this type should help considerably to transform automated decision-making systems into tools for general community use.

Improvements in the Human-Machine Interface

Closely related to access problems are a set of problems in the area of human-machine interface. Computer use over the past 25 years has matured to the point where modern society as we now know it could not function without computers. In the recent past remote access to computers over telephone lines and interfacing of different computers via telephone lines has lead to integration of the computer into information technology. The computer is now affecting the average citizen in a direct manner. Local governmental units are converting to machine-based information systems with computer terminals. Banks are beginning to provide twenty-four hour service with the customer serviced through a human-machine interface. Clerks in retail stores deal with the customer using a terminal with entry at the time of the sale. Machine aided delivery of medical care is happening in the home as well as in the clinic and on the hospital floor. And of course there is CAI. Thus there is a need to give careful attention to the human and technical problems of interfacing the non-technically trained citizen to machine-based information systems, particularly in the delivery of social services.

Even a cursory review of the current state of this field points up the enormous gap between the state-of-the-art, as represented for example by the advanced graphics and speech recognition work supported by the Advanced Research Project Agency (ARPA) of the Department of Defense (3), and the actual interface devices available to most of society for use in interacting with our computer based tools. Thus, while CIS will probably provide some support to advancing the technical frontiers of this field, greater emphasis will probably be placed on trying to integrate existing and quasi-existing technologies with a full understanding of human perception and communication capabilities so as to produce significantly improved interface systems, particularly for semi-technical and non-technical users.

Problems and Opportunities in Simulation and Modeling

Computer simulation, both pure process modeling and gaming which employs human decision-making in the model, is being looked to increasingly as a tool for the researcher, student, and practitioner in areas as diverse as urban land use planning and international relations. Its use has been stimulated lately by the development of new, sophisticated models for analysis of pollution control, land usage, and other socially important areas of of concern. Its impact has been most directly brought home to the political establishment by the Club of Rome project whose conclusions challenged sharply certain assumptions and attitudes held dear by much of society.

The social costs of accepting the results of such a global model are enormous, yet the potential danger of ignoring them, if they are correct, is even greater. Hence there is much doubt and hesitancy about accepting these models as bases for decisions, and a need to establish a rational base for designing them, evaluating them and incorporating them into the decision process in such a way that basic social values are not trampled.

The research implied is multidisciplinary and requires understanding of both the technology of system building and the social context in which the system will be installed. At the moment we find ourselves better able to frame questions than suggest conclusions. A few examples are perhaps appropriate:

- What effect can or does computer simulation and modeling have on decision-making patterns? Are there data which indicate how equivalent results, based on analytic computer models, are used and interpreted by various classes of decision makers? How important is the mode of presenting the results, and does the presentation tend to dominate over the source of the output data?

- How does one go about structuring models so that value orientation functions are an explicit input subject to easy identification and evaluation?

- What procedures do we need to develop to allow validation of the model? This question relates to the accuracy of the data base, of the relational equations and of the coefficients in the calculation. Are computational methods stable?

Problems and Opportunities Related to Information Systems for Management and Decision Making

Many years ago management information systems were promoted and prophesied to have great effects on organizational structure. Middle management, it was argued, would disappear. This event has not occurred and appears unlikely in the near future. The systems, themselves, have not proved easy to construct, and even when built, they have often not been accepted with alacrity. Yet, as we argued earlier in this paper, the pressure exists in the form of information overload and system complexity.

Once again, MIS systems appear to be on the move as management tools, this time with complex simulation models attached, and once again organizational changes are hypothesized: Planners and managers in industry and government are turning to data management and computer modeling as tools in their work. A new dimension is the interest of citizen action and watchdog groups. To design effective and useable systems, however, a lot remains to be learned about the methodology of construction and the user interface. How are

decisions made and what role does information play in decision making at various levels? How do administrators change their style of operation when presented with a good MIS system and what destructive effects does a bad system have?

One problem in the past has been for managers to evaluate the requisite background for persons hired to design administrative systems. A project supported by the Office of Computing Activities addressed this specific question in preparing for the ACM a recommended graduate curriculum for a specialist in management computing (4). This work also took a long step toward defining topics for a field of research which has been developing rapidly.

Simulation systems present their own brand of special problems as we indicated earlier. There are methodology questions which are concerned with the design of large simulations and the validation of their parameters, their relational equations and the numerical procedures for calculating results. However, there are also important impact questions concerning how simulations are evaluated and used by planners. After all, some of the so-called "counter-intuitive" results are quite challenging to existing social assumptions, exacting a sizeable social cost to act upon, yet threatening calamity if no action is taken. Even ethical questions concerning presentation of results prematurely arise in considering the social impact of simulations and elaborate information management systems.

The four examples we have provided in this section obviously represent only a subset of the areas of research interest which fall under the NSF Computer Impact on Society programs as summarized in Table 1. Of course some of the proposals submitted will contain elements to be considered under several program areas or deal with topics not explicitly mentioned in the program summaries in Table 1. In addition grant proposals are expected which will overlap with CIS and other NSF programs and may be joint funded. Because of the interdisciplinary nature of the field the Computer Impact on Society staff have been careful to maintain wide communication and coordination within the NSF and with other Federal and private programs.

PUBLIC LITERACY

The computer science professional community has grown increasingly concerned that the public does not understand computer based technology. Unfortunately, the profession's response has often served more to sharpen public misunderstanding and apprehension than it has to provide a balanced public understanding of the strengths, limitations, and dangers of computer based tools. The professional with his close and complete understanding of what is theoretically possible, has tended to overlook the very real problems of system development and implementation and focus on a longer term set of desired applications. Frequently in his efforts to "sell" his technology to the public he has failed to recognize that public apprehension is not based simply on a lack of understanding of technical detail but also on a vague perception of the very real potential for negative impacts which computer based technologies carry (5, 6, 7). The failure to recognize this vague perception as legitimate and to deal with it directly as a serious problem has been an important failing which will not be properly redressed until the wider emergence of a new group of socially oriented computer professionals.

We have yet to arrive at a fully satisfactory definition of what we mean by public "computer literacy." Certainly we do not mean simply the ability to write ALGOL or BASIC programs, although we agree that some formal experience in algorithm construction or programming is very desirable. Instead we are concerned with the problem of providing members of the general public with a more concrete understanding of the broad capabilities and limitations of computer based technology so that they may participate more meaningfully in public decision making processes as they relate to the use and control of this technology. We do not look to programs which will instill "computer appreciation." We are anxious to identify ways in which a complete and balanced picture of the technology can be provided so that we can move past the stage of public relations toward serious public discussion of the basic value questions and policy options.

THE EMERGING "SOCIALLY ORIENTED COMPUTER PROFESSIONAL"

The problem examples which we outlined in an earlier section have one important common element. Successful work in any of these fields will require a strong interdisciplinary approach which combines solid capabilities in computer science with significant skill in several fields of social and political science. We are persuaded that success will require not just interdisciplinary research teams, but individual researchers who combine focused technical expertise with broad multidisciplinary problem perception. This is not to question the importance of specialization but rather to suggest an important new motivation for developing specialized skills...the desire to work effectively on societal problems with a strong informational technology component.

The specialized training required for such work should draw its definition from a clear awareness of social needs, not from some a priori definition of a specialization area.

There is already a clear recognition on the part of some computer scientists that current training and research programs must be supplemented with programs which will lead to the creation of a new group of "socially oriented computer professionals." Examples of this trend include the proposed graduate program in "Social Information Systems" at Purdue University, the proficiency recommendations of the ACM Committee on Computer Education for Management (4), the growing list of serious courses and graduate workshops in computers and society, and several of the activities of the ACM's Special Interest Group on Computers and Society (SIGCAS). By offering sustained research support in this field the new Computer Impact on Society programs of NSF should help to further stimulate and provide added legitimacy to this trend.

In urging the development of a body of "socially oriented computer professionals" it is important to abstain from implying that these will be "better" professionals. They will be simply professionals whose training prepares them to attack a different but equally important set of research questions.

One area of classification which is likely to result in problems as one works to stimulate the emergence of "socially oriented computer professionals" is that of basic versus applied research. In fact, there is not a sharp distinction between basic and applied activity but rather a full continuum which runs from basic research, to mission oriented research, to system development, to implementation. It is important, that the researcher avoid classifying himself too rigidly as applied, basic or developmental and thus bound his work artifically. Many activities cannot be placed at a discrete point in this continuum but span a wide segment. Thus one often finds that many socially related basic research questions are best defined and categorized by undertaking what at the outset appears to be essentially system development and implementation.

This feedback from the societal sector into theoretical problem definition runs counter to some traditional academic research patterns and represents one of the more important structural changes which will be stimulated by the emerging "socially oriented computer professional."

ACKNOWLEDGEMENTS

We acknowledge with thanks the contributions of Ronald E. Anderson, Department of Sociology, University of Minnesota, who spent the summer of 1972 as a member of the staff of the Office of Computing Activities, and of many interested and enthusiastic visitors.

Finally we acknowledge the interest and commitment of John R. Pasta, Head, Office of Computing Activities, NSF, who brought one of us (PGL) here with the explicit charge to bring into being a new NSF initiative, Computer Impact on Society.

NOTES:

1. "Guide to Programs - Fiscal Year 1973," National Science Foundation publication NSF 72-23.

2. Oettinger, Anthony, A Bull's Eye View of Management and Engineering Information Systems, reprinted in Information Technology in a Democracy, Alan F. Westin (ed) Harvard University Press, 1971.

3. ARPA's address is 1400 Wilson Blvd, Arlington, Virginia.

4. "Curriculum Recommendations for Graduate Professional Programs in Information Systems". A report of the ACM Curriculum Committee on Computer Education for Management, Daniel Teichroew Chairman, R. L. Ashenhurst report editor, Communications of the ACM, 15, p. 364, May 1972.

5. Weizenbaum, Joseph, On the Impact of the Computer on Society, Science, p. 609, May 12, 1972.

6. Cousins, Norman, Humans Versus the Computer, World, p. 18, February 13, 1973.

7. Allen, Henry, "The Age of the Computer Bandito" Potomac, p. 12, February 25, 1973.